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Articles:

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Investigation of mutagenicity of mineral trioxide aggregate and other commonly used root-end filling materials

Kettering JD, Torabinejad M. Investigation of mutagenicity of mineral trioxide aggregate and other commonly used root-end filling materials. J Endodon 1995;21:537-9.

PURPOSE: To examine IRM, Super-EBA, and mineral trioxide aggregate (MTA) for mutagenic potential.

M&M: The plate incorporation assay of Maron and Ames (1983) was conducted using two *Salmonella typhimurium* test strains. Master plate cultures of organisms were stabilized for 1 mo, and then added to a cofactor mix and test root-end filling material. After 48 h incubation, histidine-independent revertant colonies were counted. Positive controls included metabolically active agents and direct mutagens.

RESULTS: Test organisms demonstrated a low spontaneous reversion rate. The root-end materials did not produce higher reversion rates against either test strain, or with direct or indirect treatment. All colony counts were within a reasonable variation from the spontaneous revertant rate for both organisms. No significant differences were found between any combination of samples, treatment, or organism.

C&C: The ideal root-end filling material should certainly not be mutagenic! The findings of this study indicate that MTA, IRM, and Super-EBA do not appear to be mutagenic when examined by the Ames Test. Another important step in establishing the safety and biological tolerance of a potential root-end filling material (MTA), and clear the way for human clinical studies.

November 1995 **Christopher F. Bates**

Effect of bleaching agents on dentin permeability to Streptococcus faecalis

Heling I, Parson A, Rotstein I. Effect of bleaching agents on dentin permeability to Streptococcus faecalis. J Endodon 1995;21:540-2.

PURPOSE: To examine the effect of several bleaching agents on the permeability of dentin tubules to *Streptococcus faecalis.*

M&M: Sixty extracted bovine incisors were sectioned 5 mm apical to the CEJ, a standard cavity was prepared with a round carbide bur, the pulp tissue was extirpated, and remnants of soft tissue and smear layer removed. The specimens were divided into 4 groups, each treated with one of the following solutions: (1) 30% hydrogen peroxide; (2) sodium perborate and 30% hydrogen peroxide; (3) sodium perborate and distilled water; and (4) distilled water. The solutions were sealed in the teeth and incubated for 7, 14, and 21 days. The teeth were then incubated in brain heart infusion infected with *S. faecalis.* After 14 days the teeth were fixed and decalcified, sectioned and stained, and the maximal bacterial penetration for each group was measured.

RESULTS: A statistically significant increase in bacterial penetration was found in the groups treated with sodium perborate/30% hydrogen peroxide (the highest) or with 30% hydrogen peroxide alone. The group treated with sodium perborate and water did not show an increase in bacterial penetration, and was similar to the control; in fact, a significant decrease in bacterial penetration was found in this group when treatment duration increased from 7 to 21 days.

C&C: Cvek and Lindall, 1985, suggested that bacterial contamination may contribute to bleaching-associated root resorption following initial periodontal injury due to hydrogen peroxide leakage. The present study shows a correlation between dentin exposure to Superoxol and its permeability to *S. faecalis*, indicating that the use of hydrogen peroxide bleaching agents may increase bacterial penetration through dentinal tubules. Sodium perborate with water did not increase dentin permeability. Holmstrup et al., 1988, showed that a sodium perborate and water mix was an effective bleaching agent without associated resorption problems. Therefore, the use of Superoxol in intracoronal bleaching is not recommended.

November 1995 **Michael Hall**

Effect of calcium hydroxide paste dressing on uninstrumented root canal wall

Wakabayashi H, Morita S, Koba K, Tachibana H, Matsumoto K. Effect of calcium hydroxide paste dressing on uninstrumented root canal wall. J Endodon 1995;21:543-5.

PURPOSE: To evaluate the dissolving effect of calcium hydroxide on the uninstrumented root canal wall.

M&M: 15 extracted, single-rooted, human teeth were split into mesial and distal halves, after which the exposed pulp tissues were removed by forceps. After washing, the 30 specimens were divided into 3 groups of 10 each, which were applied with calcium hydroxide/saline (1 g/ml) paste for different periods of time. The controls received no treatment, and were immediately fixed. The 1-wk specimens were completely covered with paste, and stored in an incubator at 37ºC. 4-wk specimens were similarly treated, and replaced into newly prepared paste weekly. After the experimental periods, specimens of each group were ultrasonically cleaned for 10 min, and examined for morphology of the root canal wall using scanning electron microscopy.

RESULTS: In the control group, most areas showed odontoblasts gathered in a layer, beneath which a thick layer of fibrous tissue was found. The 1-wk group presented no cell bodies or fibers on the canal wall, except for scattered debris. A flat predentin surface with many openings of ~2µ diameter was observed. Odontoblast projections were inside the openings of the predentin. Calcospherites were not exposed on any 4-wk specimens. Openings of the predentin were 5-10µ in diameter and were vacant, without odontoblastic projections.

C&C: This study did show limitation of the dissolving effect of calcium hydroxide paste; however, under clinical conditions the paste would have been applied following sodium hypochlorite irrigation, and canal cleaning procedures. After clinical chemomechanical preparation, the amount of remaining soft tissues is considerably smaller than that of this experiment, and sodium hypochlorite has been shown to dissolve the predentin completely within hours (Wakabayashi et

al., 1993). Thus, calcium hydroxide paste appears to be a quite efficacious debridement aid, when the entire canal is filled.

November 1995 **Christopher F. Bates**

Microbial induction of dentinal caries in human teeth in vitro

Nagaoka S, Liu H-J, Minemoto K, Kawagoe M. Microbial induction of dentinal caries in human teeth in vitro. J Endodon 1995;21:546-51.

PURPOSE: To determine if *Lactobacillus, Streptococcus,* and/or *Actinomyces* could induce dentinal caries in vitro.

M&M: 28 caries-free human premolars were used. A 2-mm deep Class I cavity was prepared in each tooth with a #330 bur, and the teeth were amputated at the CEJ. The crowns were inoculated with *L. casei, S. sobrinus, A. viscosus,* and *S. salivarius* in monoinfection groups, and *L. casei* with either *S. sobrinus* or *A. viscosus* in mixed-infection groups. Incubation occurred at 37º C for 4 or 12 wk in an anaerobic chamber. After these time periods, the samples were prepared for histological study using Brown-Brenn staining, immunohistochemical staining, and contact microradiography.

RESULTS: The pH of the incubation medium fell rapidly as bacteria were added, going below 5.5, the critical pH for decalcification of teeth, either on the 1st or 2nd days for all groups. Bacterial invasion rates for groups with 12-wk incubation times were about twice as high as that for groups with 4-wk incubation. Decalcification was seen in all samples.

C&C: This study demonstrated that *L. casei, S. sobrinus,* and *A. viscosus* could all penetrate artificially exposed dentinal tubules and induce dentinal caries. *L. casei* showed faster penetration rates when part of a mixed infection with *S. sobrinus* than it did as a monoinfection, suggesting a cooperative process. This indicates that lactobacillus might play an important role in the initiation and progression of dentinal caries, and that it might show a cooperative cariogenicity when mixed with other species which is greater than its individual cariogenicity.

November 1995 **Michael Hall**

Pathogenicity of bacteria using a simulated root canal system

Yanagiguchi K, Kawaguchi M, Egashira S, Oyama K, Yoshida H, Matsumoto H, Yamada T, Okabe H. Pathogenicity of bacteria using a simulated root canal system. J Endodon 1995;21:552-6.

PURPOSE: To examine the individual pathogenic capacity of three strains of bacteria, using an in vitro root canal model.

M&M: In the first experiment, bacteria (*Actinomyces israelii, Streptococcus faecalis, and Porphyromonas asaccharolyticus*) were injected into cut Teflon columns (with one opening of 2 mm in length and 0.5 mm in diameter). 4 models were subcutaneously implanted into each of 20 rats. After 1 wk, the models with their surrounding tissues were removed for histological study. For the 2nd experiment, 2 model implantations and 2 bacterial solution injections were performed on each of 60 rats, using only *P. asaccharolyticus*. 20 rats were killed at 1, 2, and 4 wks. Inflammatory responses were assessed and compared.

RESULTS: After 1 wk of bacteria-filled model implantation (experiment 1), thick, inflamed fibrous tissue capsules with hyperemia were observed. *A. israelii* and *S. faecalis* caused either a moderate or severe inflammatory response (equal frequency), whereas most specimens in the *P. asaccharolyticus* group had severe inflammatory responses. Almost no inflammatory responses were observed for both the group injected with bacterial suspension and the one injected with saline (experiment 2). After 1 wk, inflammation around infected models was similar to responses found in experiment 1. Only slight inflammatory responses still remained about experimental models at 2 and 4 wks (not significantly different from saline controls).

C&C: The root canal models used in this study were designed to allow slow diffusion of the bacterial suspension, such as might occur clinically. Host defenses were easily capable of responding to and eliminating the injected bacteria; however, the root canal model provided protection for the microorganisms, and facilitated their survival. This study clearly indicated that *A. israelii* and *S. faecalis* produced milder inflammatory responses than *P. asaccharolyticus*. Of course, a mixed bacterial flora occurs in canals clinically, and could behave differently.

November 1995 **Christopher F. Bates**

A mathematically based classification of root canal curvatures on natural human teeth

Dobó Nagy C, Szabó J, Szabó J. A mathematically based classification of root canal curvatures on natural human teeth. J Endodon 1995;21:557-60.

PURPOSE: To describe root canal curvatures mathematically, and to provide a standard, practical, and reproducible root canal alignment for research purposes.

M&M: 433 human roots were used. The pulps were extirpated and the canals filled with a radiopaque material. Radiographs were taken in the clinical view. Schneider's angle of curvature was determined. Seven points for each root canal axis were plotted, and coordinates of all the points were fed into a computer, which determined root canal axes by 4th-degree polynomial function approximation.

RESULTS: Root canal forms were classified into 4 groups: straight or I form (28%); apical curve or J form (23%); curved canal along it entire length or C form (33%); and multicurved or S form (16%).

C&C: Schneider's method does not provide enough information on curvature change throughout the length of the root canal. The results of this study showed that 40% of the 433 roots could be classified as other root canal forms contrary to the Schneider angle classification. The advantage of the mathematical classification is that it helps to describe multicurved canals. Scheider's method is worthwhile for everyday practice, but a more exact method of determining curvature would be useful in research, especially in root canal preparation and obturation tests.

November 1995 **Michael Hall**

Microcomputed tomography: An advanced system for detailed endodontic research

Nielsen RB, Abdalmajeid MA, Peters DD, Carnes DL, Lancaster J. Microcomputed tomography: An advanced system for detailed endodontic research. J Endodon 1995;21:561-8.

PURPOSE: To evaluate the potential of microcomputed tomography (MCT) in endodontic research; specifically, its ability to: (1) evaluate internal and external morphology of dental hard tissues; (2) assess the volumetric and surface area change of pulpal spaces relative to regular and irregular dentin formation; (3) assess volumetric and surface change following instrumentation; and (4) evaluate canal transportation following instrumentation.

M&M: 4 maxillary molars, extracted for periodontal reasons, were embedded in acrylic and imaged by an X-ray beam of 470 kVp. Teeth were accessed and instrumented. Canals in 1 large and 1 small tooth were instrumented to a size 40 with the Canal Master system. Others were instrumented to a size 40, with K-files used in an anticurvature manner. 2 teeth (1 each size and each instrumentation technique) were obturated using AH26 sealer and warm gutta-percha. All teeth were reimaged. Pulpal volumes and surface areas were determined, after segmenting from surrounding dentin. Individual slice data allowed linear measurements for canal transportation (1.5, 3 mm levels). These calculations were compared with the volume calculations made of a calcium phosphate phantom standard (known volume), using a regular hospital-based computerized axial tomography scan system.

RESULTS: Accurate volumetric calculations were possible for most tissues and spaces. The authors claimed interpretation of regular dentin and irregular dentin/dystrophic calcifications. Mesiolingual canals were identified in all 4 teeth; a 2nd ML canal was found in 1 tooth. Only 2 of the ML canals could be located clinically. Anticurvature filing transported the canal an average of 0.29 mm, whereas Canal Master instrumentation transported the canal an average of only 0.09 mm.

C&C: The science behind MCT is highly complicated, and thus the article is very tedious reading. The dramatic internal/external dental images produced by this nondestructive technique apparently have tremendous potential as a future research tool in endodontics. Demonstration of morphological relationships, calcification patterns, obliterated canal portions, and cementum segmentation was easy. The possibility of comparing irregular dentin formation relative to normal aging versus periodontal disease, orthodontic treatment, or restorative treatment was shown. Also shown was the possibility of evaluating changes in surface area and volume in normal aging or after instrumentation. Additionally, MCT might someday be useful as an interactive educational tool.

November 1995 **Christopher F. Bates**

Tissue reaction to implanted Super-EBA and mineral trioxide aggregate in the mandible of guinea pigs: a preliminary report

Torabinejad M, Hong C-U, Pitt Ford TR, Kariyawasam SP. Tissue reaction to implanted Super-EBA and mineral trioxide aggregate in the mandible of guinea pigs: a preliminary report. J Endodon 1995;21:569-71.

PURPOSE: To examine the tissue reaction of implanted Super-EBA and MTA in the mandible of guinea pigs.

M&M: Test materials were placed in Teflon cups and implanted into bony cavities prepared in the mandibles of 7 guinea pigs. Half of the bony cavities in 6 animals received Teflon cups with Super-EBA and the other half received Teflon cups containing MTA. Bony cavities in one animal were left untreated as controls. After 2 months the animals were killed, and the mandibles were dissected free and prepared for histological examination. The presence of inflammation, predominant cell type, and thickness of fibrous connective tissue around each implant was recorded.

RESULTS: The tissue reaction to MTA was slightly milder than that to Super-EBA. All Super-EBA implants had fibrous connective tissue next to the cement, while bone was observed next to one of the MTA implants. All Super-EBA implants had slight inflammation, while 3 of 5 MTA implants were without inflammation.

C&C: Based on these results, both Super-EBA and MTA seem to be biocompatible.

November 1995 **Michael Hall**

In vitro evaluation of the accuracy of several electronic apex locators

Czerw RJ, Fulkerson MS, Donnelly JC, Walmann JO. In vitro evaluation of the accuracy of several electronic apex locators. J Endodon 1995;21:572-5.

PURPOSE: (1) To test the in vitro accuracy of 4 electronic apex locators - the Digipex III, Apex Finder, Neosono-MC Plus, and Root ZX; and (2) to test the accuracy of the Exact-a-pex in both dry and distilled water-filled canals.

M&M: Pulpectomies were performed on extracted human incisors and canines, using K-Flex files and Gates Glidden drills. The tip of the tooth being tested was placed into set gelatin, as was the lip clip. The other test lead was attached to a small file, which would bind just short of electronic length. Once the device indicated the apex was reached, files were measured to the nearest 0.5 mm. In part 1, canals in 30 teeth were dried prior to length determination. File lengths were visually remeasured to the point at which the tip was just visible at the apical foramen. Results were considered clinically significant if the device measurement was greater than the visual length by 0.5 mm or more. In part 2, electronic (Exact-a-pex) and visual canal lengths were compared in 15 teeth, using both wet and dry canals.

RESULTS: There were no significant differences between visual canal length measurements and those attained with the Digipex III or the Root ZX. Clinically significant variances were observed with the Apex Finder (16.6%) and the Neosono-MC Plus (10%). All measurements were identical using the Exact-a-pex when the canals were dry or filled with distilled water.

C&C: For the most part, the differences found in this study were slight enough to be of no clinical significance. When differences existed, the device length was always longer than the visual length. The Apex Finder and the NeoSono-MC Plus had 5 and 3 measurements, respectively, that were 1.0 mm longer than visual length. These 8 teeth could not have been prepared with an apical barrier, even considering a 1-mm step back from electronic to working length. A previous study (Czerw et al., 1994) showed the Exact-a-pex to exhibit 100% agreement between electronic and visual lengths. Apparently, it also works well "under water".

November 1995 **Christopher F. Bates**

Redemption of a perforated furcation with a multidisciplinary treatment approach

Goon WWY, Lundergan WP. Redemption of a perforated furcation with a multidisciplinary treatment approach. J Endodon 1995;21:576-9.

PURPOSE: To present a case report of the treatment of a long-standing lesion associated with an undetected furcal perforation in a mandibular molar.

CASE REPORT: A 27-yr-old female was seen for #19 in June 1991 which was sensitive to chewing and to touch. Radiolucent lesions were noted at the apex of the M root and in the furcation area. The tooth had been restored with screw-type posts and a crown. The presence of a 6 mm periodontal pocket with associated furcal destruction was evidence of a furcal perforation. The crown became loose and was removed by the patient, and the composite core build-up and posts were removed during retreatment. Purulent exudate drained from the MB orifice. The tooth was re-treated endodontically in October 1991 and heat-softened GP was used to try to seal the furcal perforation. The tooth did not heal, so an attempt at GTR was decided in February 1992. Gore-Tex was used, and attachment was evidently gained. However, during follow-up in November 1992, the authors felt that the perforation site was leaking since bony regeneration had slowed radiographically, so the chamber was reentered. Exudate was noticed, so the perforation site was sealed this time with Ketac-Endo, followed by IRM and amalgam. The tooth was asymptomatic in March 1993, and almost complete osseous regeneration had occurred by December 1993.

C&C: This case showed that elimination of endodontic microleakage from the perforation site coupled with GTR enabled osseous regeneration and pocket elimination to occur in a severely compromised lower molar. Furcal extrusion of a moderate amount of Ketac-Endo did not seem to affect the healing. Perio studies have shown the effectiveness of GTR procedures in class II furcations, but sealing of the perforation was the key to ultimate healing in this case.

November 1995 **Michael Hall**